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EDITORIAL

The Nuffield Professorship of Anæsthetics

THE first occupant of the Chair of Anæsthetics in the University of Oxford, established through Lord Nuffield's endowment, is Mr. R. R. Macintosh, F.R.C.S. (Ed.), Anæsthetist to the Throat Hospital, Golden Square, and Lecturer on Anæsthetics to the National Dental Hospital. Mr. Macintosh, to whom we extend our hearty congratulations, is in his fortieth year, and is well known to London anæsthetists through his work in anæsthetics for operations on the upper air passages, and for the successful co-operation of several anæsthetists in private practice which he organised. We imagine that it must be many months, probably several years, before fruit can be forthcoming from the new tree of anæsthetic endeavour which Lord Nuffield has planted. There will be much to be done, we presume, in extending and in organising the clinical work in anæsthetics which already goes on at Oxford in the Radcliffe Infirmary, the Orthopædic Hospital, and elsewhere. In addition the new Professor will doubtless be responsible for organising all the teaching of his subject, as well as for

originating, if not supervising, researches that may be undertaken, whether on the clinical, physiological, pharmacological or biochemical aspects of anæsthesia. He has before him a difficult but a most interesting and promising task. We believe that the new Professor has the qualities of initiative, open-mindedness, energy and courage, without which such a task could not be tackled with success. We look forward with confidence to the advance of the study and practice of anæsthetics at Oxford under his guidance, and hope that in future numbers of this journal we shall often be able to put before our readers an account of progress due to the unique establishment which Lord Nuffield's generosity has brought into being. We understand that working with the Professor there will be one first assistant, probably selected from London, two senior assistants chosen from anæsthetists already working in Oxford, and five junior assistants. These last would be resident officers, receiving £100 a year and their keep, and would hold office long enough for them to become skilled administrators and teachers.

THE DIPLOMA IN ANÆSTHETICS

THE Diploma has been granted, under the special conditions of the regulations, to Harry Richards, L.R.C.P., M.R.C.S., and to R. O. Pramanik.

NOTES ON CURRENT ANÆSTHETIC METHODS AT THE MAYO CLINIC, AT TORONTO, AND AT WINNIPEG.

D. C. Aikenhead, M.D. (Winnipeg, Man.);
John S. Lundy, M.D. (Rochester, Minn.)
Harry J. Shields, M.B. (Toronto, Ontario).

Collected by H. W. FEATHERSTONE, M.D., D.A.

IN preparation for a recent discussion on anæsthetics in United States and Canada, which was held by the Section of Anæsthetics of the Royal Society of Medicine, the writer addressed questionnaires to several friends in those countries. Unfortunately two of the replies arrived too late to be included in the discussion; but in view of the very important and comprehensive information which Dr. Aikenhead, Dr. Lundy, and Dr. Shields have provided there can be little doubt but that the readers of this Journal will be very glad to have the opportunity of studying their replies.

In 1930 the writer, with other English anæsthetists, visited the clinics mentioned, and the questions were framed with the view to ascertaining the changes which had occurred since that time.

THE MAYO CLINIC

Dr. Lundy, Chief of the Section on Anæsthesia at the Mayo Clinic, has answered *seriatim* the questions which were put to him.

1. *Is the Section on Anæsthesia organised on similar lines to the arrangement in* 1930?

ANSWER.

The arrangement of the Section on Anæsthesia has changed somewhat since 1930. The next report which

will be presented by us will be on April 7, and it should appear in print that month. From that report I can give you some information which might be of some interest to you. During 1936 there were 5166 cases of injections of local anæsthetics, of which 2737 were spinals. We used intravenous anæsthesia 2745 times. In 5.66 per cent of our cases we used an intratracheal tube. We used the intrapharyngeal method only 37 times. A comparison of the use of special methods and of ordinary methods of anæsthesia shows that special methods were used in 71.07 per cent of the cases, while ordinary methods were used in 28.93 per cent of the cases. Special methods include cyclopropane, intravenous, intratracheal, intrapharyngeal, and regional, including spinal, methods of anæsthesia. Of the 2057 blood transfusions done, the Section on Anæsthesia administered the blood in 76.66 per cent of the cases.

The number of doctors in this Section has increased to ten, and will continue to increase so that by the time I shall have been here fifteen years (which will be two years from next month), I expect there will be fifteen of us. We still have a technician in each operating room, who attends to the routine duties, such as making out the records, helping put the patient on the operating table, and cleaning the gas machine and other appliances used in the operating room. She administers gases and ether. She is supervised by a physician-anæsthetist who is constantly making rounds from one operating room to another so that intentional intervals between periods of supervision are not more than ten or fifteen minutes. She is never permitted to anæsthetise a patient by herself; there must always be a doctor in the room, even though that doctor is not an anæsthetist. The convenience of having the technician is considerable. She may sit with the patient to whom a spinal anæsthetic has been administered and make a record of the blood-pressure, pulse, etc., and if conditions are at all questionable, a physician-anæsthetist is called and he takes charge of the situation until conditions are satisfactory. The technician is valuable in connection with intravenous anæsthesia, as she can support the jaw and regulate the "butterfly" of paper or cotton which is fastened to the

patient's upper lip, and she can thus watch respirations. In some operating rooms we use physician-anæsthetists to administer general anæsthetics, and the number of these physicians depends upon the number of men who are taking the three-year fellowship in anæsthesia at the Mayo Foundation.

This fellowship was made available in March 1929. Since that time there have been a number of men who have availed themselves of this opportunity for training, and my associate, Dr. E. B. Tuohy, was granted a Master of Science degree in June 1936 by the University of Minnesota. His diploma is, so far as I know, the first one that has been granted in the United States; the only other one in North America has been to Wesley Bourne from McGill University. I expect that there will be others now from time to time, as we have fellowship men who will complete their training at intervals beginning in June 1937.

The opportunities for training are limited only by the work that is done by the consultants in the Section and our first assistants. A fellowship man devotes six months, as a rule, to physiology, making that his minor, and he writes a thesis concerning his work. He spends six months in internal medicine, nine months in general anæsthesia, and a year or more in special methods of anæsthesia, such as regional anæsthesia, including spinal, intravenous anæsthesia, rectal and intratracheal anæsthesia. During this three years there will be times when it can be arranged for a man to do some reviewing in anatomy. He has the opportunity to see bronchoscopy carried out, and also oxygen therapy. He becomes well trained in the transfusion of citrated blood, diagnostic and prognostic injections of local anæsthetics, and assists in the management of patients who are difficult to handle, whether they have become psychotic or have convulsions, or for any other reason have become unmanageable.

In the chemistry laboratory, physics laboratory, the Institute of Experimental Medicine and Surgery, and our library at the clinic, a man may extend himself in his educational activities as much as he wishes. It is my plan that each consultant in Anæsthesia (and I hope to have four

besides myself inside of the next two or three years) will have as his hobby some special and interesting part of the teaching. For example, one will make chemistry his hobby, another will have charge of the anatomy laboratory which is operated by the Section on Anæsthesia. Another man will major in biometrics and will have charge of our records and will be of great assistance in the understanding of statistics and how they may be presented. The various phases of these statistics will interest our fellowship men, especially after they have finished their work here and have gone elsewhere. They will find their training in connection with records and statistics valuable, especially if they are to establish their own system in another new place. Another man will probably specialise in physical examinations and in estimation of anæsthesia and operative risk, the best methods of preparing a patient for anæsthesia and operation, and proper measures for dealing with complications during and after anæsthesia and operation.

I am enclosing a list of operations for Saturday, February 20th. You will note that we have to do with the administration of intravenous solutions, especially in those individuals in whom venipuncture is difficult. By consulting other members of the staff, our fellowship men should be prepared, not only to administer anæsthetics, but, we hope, to go out as the head of a department of anæsthesia. At the present time the demand for such men cannot be met. I have several institutions in mind who are impatiently waiting for men to finish the fellowship course, and the starting salary has not been less than $5000 a year. It has taken years to bring this opportunity to the attention of those who might be interested, but now that the demand exists it will not be long before many will be in training, and I expect that in the next ten years anæsthesia will have advanced in the United States faster than in any other corresponding period of its history.

It is especially noticeable that the demand now is not for a man who administers general anæsthetics only, but for men who are familiar with all the present methods that are commonly used, regional, intravenous, rectal, inhalation, and so forth, so that the large group of anæsthetists in

practice to-day do not serve as the answer to our future problem. We are also planning that, in the future, a man will be less vulnerable in periods of depression, should they recur, if he is interested in practising the transfusion of blood, oxygen therapy, and the things that I have already mentioned.

In each of the four hospitals we shall have a consultant in charge, with several second assistants and one first assistant. The consultant will have his own nurse or nurses in the "local room", which is adequately prepared for the administration of local anæsthetics by the various methods, and for the transfusion of blood. It is the headquarters for the personnel concerned with the administration of anæsthetics. Certain special equipment is installed there, and it has become almost indispensable in the suite of operating rooms. Some hospitals have anæsthetising rooms, but they have not been utilised as we are utilising our anæsthetising room, which, of necessity, must be rather large.

2. *Do you employ nembutal and sodium amytal frequently?*

ANSWER.

Nembutal and sodium amytal are seldom used intravenously, although they are still one of the best methods of controlling convulsions, as, for example, from tetanus, for the control of psychotic individuals, or for quick relief in patients with intolerable pain who are moribund.

Nembutal is used here mostly as pre-operative medication in a dose of 1½ grains by mouth the night before operation, and 1½ grains at seven o'clock on the morning of operation. Besides this, pre-medication usually consists of 1/6 grain of morphine and 1/150 grain of atropine by hyperdermic injection one-half hour before operation, and preferably not more than forty-five minutes before.

In general, amytal is used in the medical cases, while nembutal is used for the surgical patients.

3. *What do you think of avertin and sodium evipan?*

ANSWER.

Avertin is seldom used here, I believe largely be-

cause of our frequent use of the intratracheal method. However, there are times when it is indicated, especially where conditions must be fireproof, as in the use of cautery or diathermy in a case of tumour of the pharynx when the patient is quite resistant to the ordinary anæsthetics. However, when we do use it we use it as a basal anæsthetic, and make up the difference with a local anæsthetic or nitrous oxide when conditions must be fireproof. I believe that it is a valuable drug, and is of considerable benefit to those men who do not use the intratracheal method.

In regard to sodium evipan, we have used it here with satisfaction. In my opinion it has much merit or it would not have survived the abuse it was subjected to when the technique for its administration was to inject a quantity of it, remove the needle, and proceed with the operation. We have used pentothal sodium employing the intermittent method of administration in between four and five thousand cases.

We prefer this drug to evipal because of its increased potency. Occasionally there are patients who are resistant, and the number of failures with pentothal sodium are fewer than I believe they would have been with evipal. These two drugs, however, I think have re-established intravenous anæsthesia on a basis which will not be as transient as was the case with amytal and nembutal. My associate, Dr. R. C. Adams, should finish this summer or autumn, a monograph on the history of intravenous anæsthesia to date, which I think will be a very desirable publication to read and own. My own efforts to prepare a textbook on anæsthesia are interrupted so frequently that I have only a chapter or two of the whole book written thus far.

4. *Is ethylene still used on a large scale?*

ANSWER.

The use of ethylene has decreased considerably here, partly because of the great increase in the use of intravenous and regional methods of anæsthesia, and also because we use cyclopropane frequently.

5. *Have you any definite views on cyclopropane?*

ANSWER.

I have a few very definite views on cyclopropane. There is a great deal of discussion about the use of this agent, because of occasional sudden deaths. Dr. Guedel, of Los Angeles, believes that these sudden deaths are due to cardiac fibrillation, and believes that nothing can be done about it. He also believes that it gives no warning, and that treatment for it is ineffectual. He also thinks that it rarely happens.

A patient in New York died last year after about forty minutes of cyclopropane anæsthesia while she was having a femoral hernia operated on. She was in perfectly good health otherwise. I know of this case because her husband was a doctor and a friend of mine, and he wrote me about it. Nothing was found at autopsy. I saw a strong, but frightened, thirty-four-year-old female patient die on the table before the operation was even started, however, this patient did not die suddenly, but gradually succumbed, respiration becoming shallower and her colour poorer, finally respiration stopping altogether. Apparently, breathing and cardiac function failed together.

Just this last week I was consulted by mail about a case in which a patient had died after cyclopropane administration. The patient was an apparently healthy young man of twenty-four years, and the operation, which lasted forty minutes, was for bilateral hernia. His colour was good and his pulse was 120 until about one-half minute before he went bad. His respirations were good, but all of a sudden he turned white. The nurse anæsthetist, who had given many thousands of anæsthetics, informed the doctor of the condition and stopped the anæsthetic. Artificial respiration and coramine were administered and other measures were tried, but the patient never responded. The anæsthetist asserts that she at no time had given more than 600 c.c. for one minute at a time, and the patient seemed to require less than other patients. The trouble occurred at the end of the operation. No information was gained from the autopsy.

I do not pretend to know the whole story, since others who are competent are confused about it, but I am proceeding on this basis, which appeals to me as being relatively safe: that is, that the patient does not breathe a concentrated mixture of cyclopropane and oxygen to begin with. The concentration of cyclopropane is gradually increased, the character of the pulse being watched all the while. As anæsthesia deepens from the increased concentration of cyclopropane in some individuals the character of the pulse becomes affected, so that it is different in rhythm and volume than before. At this point I believe that the heart indicates, through the altered pulse, a toxic effect from the beginning overdose, and I think if this is carried on and anæsthesia is deepened with increasing amounts of cyclopropane, that the pulse will continue to become less regular and less full. Finally the pulse is difficult to palpate, and one still has an opportunity to turn back and use less concentrated mixture of cyclopropane by either turning on more oxygen or nitrous oxide, or both, into the bag. Dr. Guedel disagrees with me that one overdoses with cyclopropane, while Dr. Briand Sword of New Haven, Connecticut, agrees very much with me that if one is going to administer this gas, the pulse should be constantly palpated, that if it is used there should be a reason for its use, and that it can be added to nitrous oxide as ether is added to nitrous oxide so that concentration can be kept to a minimal amount. Regardless of who is right in this contention, our use of cyclopropane is much more cautious than before, and because I consider it a very valuable anæsthetic agent in chest cases and in patients who have pulmonary disease who must have a general anæsthetic, where the anæsthetic can be an inflammable one and ether must be avoided, I believe it is the best agent that we have yet found. However, it cannot be administered by an inexperienced individual for very long without experiencing a fatal, unexplainable result. I believe that there has been no one who had used cyclopropane for any number of cases who has not had at least one case in which the patient appeared to be in a serious state at some time during the anæsthetisation, not because the gas is unusable,

but because the individual who used it did not realise that he could overdose with it.

6. *Do you use percaine, and if so, do you use it as a spinal anæsthetic?*

ANSWER.

We do not use percaine. I ran the first large series of spinals with percaine that were done in this country, and used it in a solution of 1:200 concentration and diluted it up with C.S.F. to 1:800. My results with it led me to think of it in relation to other local anæsthetics in the same unfavourable light as chloroform is compared with other general anæsthetics in this country.

7. *Do you use the* 1:1500 *solution of Howard Jones, or more concentrated solutions such as* 1:200 *diluted with C.S.F.?*

ANSWER.

We have not used the Howard Jones' method because we do not wish to use the drug at all. Pontcaine, while in my opinion seeming to be less toxic than, is not as safe as, procaine. We have been using metycaine in about 1000 cases intraspinally. Dr. Touhy has just finished a report on it and finds it to be satisfactory, and in some cases prefers it to procaine, especially in sacral blocks, as well as spinals.

8. *Do you ever give chloroform, and is ether alone used much?*

ANSWER.

Chloroform has not been used here as an anæsthetic since 1927. Ether is not often used alone. If it is to be used, induction is usually wth gas and ether, and we use ether by the open drop method for maintaining anæsthesia. I think it will have been used more last year and this year than for several preceding years. In all probability we avoided its use in many cases in which it would have been better to have used it.

9. *Have you any remarks to make concerning the various intratracheal methods?*

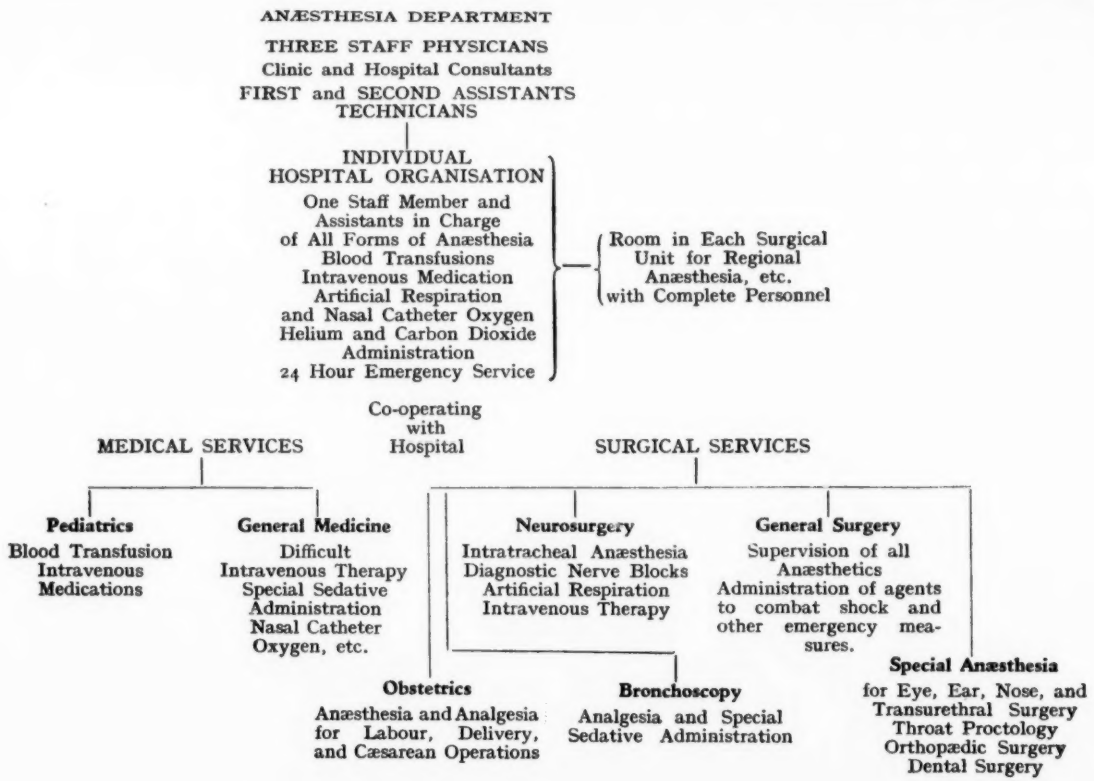
ANSWER.

Of the various intratracheal methods, I feel that that of Magill is the best. His method of blind intubation has been used here continuously since his visit in 1930, and we consider it to be one of the best of the special methods of anæsthesia that we employ. We are particularly pleased with it in cases of thoracic tumour, brain tumour, plastic operations on the face, and so forth. We use the tube both connected to the machine, and in many cases simply as an airway without connecting it to the machine. This is especially true in using the absorber where the tube can be inserted and the mask applied to the face so as to prevent leaks. We use sterile intratracheal tubes and place them in a large, curved, sterile glass tube with a cap attached, and we lubricate them with sterile white vaseline so that we shall not introduce into the patient organisms to which he may not be accustomed.

10. *What is your favourite anæsthetic method for lobectomy?*

ANSWER.

We use cyclopropane as our anæsthetic of choice in lobectomy, although I realise that it can be done under spinal anæsthesia.


ANÆSTHESIA DEPARTMENT
THREE STAFF PHYSICIANS
Clinic and Hospital Consultants
FIRST and SECOND ASSISTANTS
TECHNICIANS
INDIVIDUAL HOSPITAL ORGANISATION
One Staff Member and Assistants in Charge of All Forms of Anæsthesia
Blood Transfusions
Intravenous Medication
Artificial Respiration and Nasal Catheter Oxygen
Helium and Carbon Dioxide Administration
24 Hour Emergency Service
Room in Each Surgical Unit for Regional Anæsthesia, etc. with Complete Personnel
Co-operating with Hospital
MEDICAL SERVICES
SURGICAL SERVICES
Pediatrics
Blood Transfusion
Intravenous Medications
General Medicine
Difficult Intravenous Therapy
Special Sedative Administration
Nasal Catheter Oxygen, etc.
Neurosurgery
Intratracheal Anæsthesia
Diagnostic Nerve Blocks
Artificial Respiration
Intravenous Therapy
General Surgery
Supervision of all Anæsthetics
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Obstetrics
Anæsthesia and Analgesia for Labour, Delivery, and Cæsarean Operations
Bronchoscopy
Analgesia and Special Sedative Administration
Special Anæsthesia
for Eye, Ear, Nose, and Transurethral Surgery
Throat Proctology
Orthopædic Surgery
Dental Surgery

Toronto

Dr. Harvey J. Shields has followed Dr. Samuel Johnston as Chief Anæsthetist at the Toronto General Hospital. The questions differed slightly from those in Dr. Lundy's questionaire, and Dr. Shields replied in the following manner:

1. At the Toronto General Hospital our anæsthetic arrangements are on the same plan as in 1930. We have a staff of seven and also a resident in anæsthesia. His appointment is for one year.

2. We do not use ethylene in our hospital. We do use cyclopropane a very great deal. It has to a considerable extent replaced both nitrous oxide and ether. We use nembutal by mouth in the majority of our patients as a preliminary sedative, combined usually with morphine and hyoscine. We use very little sodium amytal. Avertin is used in encephalography in patients who will not co-operate under local anæsthesia; in a few cataract operations or in plastic work about the face. We have never made much use of this drug.

3. We use sodium evipan or pentothal (which drug we prefer) only where it would seem to be convenient, e.g., short cases where a mask will be in the way; carbuncles on the back of the neck; or where a non-inflammable anæsthetic is indicated. These cases are not numerous.

4. We use percain as a spinal anæsthetic, using the 1:1500 solution for about 90 per cent of our upper abdominal surgery. We also use it in those cases where spinal anæsthesia seems indicated that will require more than one hour. We have not had good results with the 1:200 solution of percain.

5. Chloroform and ether mixture is given in most of our ward obstetrical cases, chiefly for analgesia. Most of our private obstetrical patients will be given nitrous oxide. The only other use we make of chloroform is in some cases where diathermy is being used in the mouth.

6. We do some of our head and neck ward cases, such as block dissections, with endotracheal insufflation of ether. We also make use of cyclopropane by the endotracheal route, particularly in some of our chest cases and a few of

our upper abdominal or other operations about the head and neck.

7. We do our thorocoplasties with cyclopropane. Lobectomies done for bronchiectasis we do with spinal anæsthesia, preferring novocaine to nupercaine because the preponderant effect is on the posterior roots, not on the anterior roots as we believe the case to be with the latter drug. Recently we have been doing more of our intrapleural operations with endotracheal cyclopropane.

8. We prefer the 10 per cent solution of novocaine rather than crystals because it is cheaper and easier to grade the dose. In short operations in the lower abdomen and in genito-urinary surgery we use novocaine because we can save time by not having to place the patient in the prone position.

9. We use the carbon dioxide absorption by the circle filter for most of our work. We use Heidbrink and Foregger machines and they appear to be about equally satisfactory. We use the McKesson direct flow machines in obstetrical analgesia and in cystoscopic room and in the fracture room.

We do mostly caudal block for hæmorrhoidectomies. Apart from spinal anæsthesia and caudal block, the anæsthetic staff do not give regional anæsthetics. Brachial plexus blocks and infiltration anæsthesia for cases such as fractures, are done by the surgical staff.

Winnipeg

Dr. Aikenhead states* that at the Winnipeg General Hospital nembutal is not employed with general anæsthesia, but it is used occasionally with spinal. He likes avertin, and uses it for all brain surgery and for encephalograms. For nervous private patients avertin combined with cyclopropane is the favourite technique. 3.5 c.c. of coramine intravenously at the conclusion of the operation prevents avertin depression after the patient has returned to the

* Extract from the discussion at the Section of Anæsthetics of the Royal Society of Medicine, March 5, 1937.

ward. Aikenead prefers pentothal to sodium evipan, and believes it is at present the best intravenous anæsthetic. He says ethylene is "passé!" Cyclopropane gives better relaxation and he likes the high degree of oxygenation. He is enthusiastic concerning the good qualities of cyclopropane, having given it on more than one thousand occasions. It has yielded good results in desperate cases, and he has had no trouble from auricular fibrillation. He is not partial to percain as a spinal anæsthetic, for he finds that the onset of analgesia is delayed, and he thinks that the large bulk of fluid injected by the Howard Jones technique is too disturbing. For spinal analgesia they still use novocaine crystals dissolved in cerebro spinal fluid. If analgesia is too brief, Aikenhead injects 1/6 grain of morphine into a vein, and he states that this prolongs analgesia for nearly half an hour. They use chloroform for diathermy operations on the head and neck.

Ether is the only anæsthetic that is given by internes, and for operations of less than three-quarters of an hour duration upon patients in sound general health, he believes ether is hard to beat.

Dr. Aikenhead likes the Waters Metric Anæsthetic Table —Montreal Model—made by Foregger. They have little experience of lobectomy, but for short thoracotomies they employ local anæsthesia and pentothal.

In conclusion, the warmest thanks are due to Dr. Aikenhead, Dr. Lundy and Dr. Shields for the exceedingly interesting information which they have so willingly supplied.

NASAL ENDOTRACHEAL ANÆSTHESIA

The Other Side of the Picture

THE article on pulmonary complications following nasal endotracheal anæsthesia by Dr. Massey Dawkins, which we published in our January issue this year, has brought us so many communications that we do not think fit to relegate them to the usual position of "correspondence" at the end of a number. Accordingly, we are combining them here into one article, at the same time making clear for which portion thereof our various correspondents are responsible. The impression which we gather, both from Dr. Dawkins' article, and from those who criticise it, will probably be that aroused in the minds of most of our readers, viz. that the endonasal method, like others, depends for its virtue on the manner in which and the occasions on which it is employed. Intrinsically, it may be neither better nor worse than an old method; the manner of its employment may make it either much superior or not nearly so good.

Dr. I. W. Magill *writes*:

The formidable statistics produced by Dr. Dawkins in the last number of the Journal, of complications following nasal intubation, will be received with interest, if not with alarm, by many anæsthetists who have employed the method for years—unaware, apparently, of the risk to which they have been subjecting their patients.

It has been said, I believe, that statistics will prove anything. The value of statistics is undisputed. It is my personal regret that in the course of a busy life I have been unable to keep a complete record of each anæsthetic, as it should be kept, in every case. At the same time, although anæsthetics of a routine nature may not be tabulated, or even remembered, in my own experience any complication leaves an impression which is never forgotten. In such an

event it has always been my practice to subject my own technique to the most rigorous and unprejudiced examination.

I first employed nasal intubation about the end of the year 1919, and since that time I have continued to use it, when indicated, without any cause for regret. I have yet to record a case in which pulmonary complications could be justly attributed to the method. I would go further, and say that intubation (including nasal intubation) has contributed, through quiet respiration and lack of respiratory effort, to the general absence of pulmonary complications in my practice. I feel certain, at the same time, that had there been any evidence in my own practice of an increase in pulmonary complications following nasal intubation, the surgeons with whom I work would have insisted long ago upon the method being abandoned.

Dr. Dawkins quotes the statistics of the Mayo Clinic, which record an increase of 200 per cent intubation anæsthetics in the past six years. I have had the good fortune to observe the accurate manner in which statistics are recorded at the Mayo Clinic. It will be interesting to learn in due course whether the statistics at that centre show a corresponding increase in pulmonary complications.

In the two fatalities recorded by Dr. Dawkins, cultivation of identical micro-organisms from the nose and lungs does not necessarily prove that infection was carried by the tube. I have expressed the opinion elsewhere that bacteria which are present in the nose are probably already in the trachea (acute infections excepted). The secretions of the normal trachea in a London fog provides graphic proof of this contention.

However, Dr. Dawkins has performed good service in bringing his statistics to light. He has shown that the indiscriminate use of the endotracheal method by all and sundry, whether indicated or not, is to be deprecated. Clearly it is his duty, in the public interest, to make every effort to abolish the use of nasal intubation at the hospitals from which these statistics have been taken. When this has been accomplished it will be interesting to hear of his constructive efforts in the replacement of a method which has

proved so useful, and so free from complications comparatively, in the hands of other anæsthetists over a considerable number of years.

After Dr. Magill we give the views sent us by Dr. M. D. NOSWORTHY:

I entirely agree with your contributor, Dr. Dawkins, that it is unjustifiable, unless intubation is indicated, to complicate a straightforward anæsthetic technique with a manipulation which, in some hands, may be a hazardous undertaking.

If the anæsthetic is chosen with care and administered correctly, it is, in my opinion, mainly the nature of the operation and the type of patient which decides the incidence of pulmonary complications. If the endotracheal method was a contributory factor a high incidence should follow nose and throat operations on adults for whom this technique is nowadays commonly employed. I find, however, from records of my own cases—which, of necessity, must be few compared to the number which Dr. Dawkins has collected—that there have been no pulmonary complications in my last 50 private cases of this type (37 nasal and 13 oral intubations), and in my last 100 hospital cases (57 nasal and 42 oral intubations) there has been but one—a non-fatal hypostatic pneumonia in a man anæsthetised through a tracheotomy tube for the excision of one vocal cord.

As my experience in other branches of surgery also fails to corroborate Dr. Dawkins' findings, I am forced to the conclusion that injudicious choice of the nasal route, imperfect application of Magill's blind intubation method, or faulty maintenance of endotracheal anæsthesia must have contributed to the high incidence of post-operative complications which he has noted.

Next we have a short expression of opinion from a nose and throat surgeon, Mr. W. A. MILL:

The other day I was asked by an anæsthetist whether I thought that, in my experience, pulmonary complications were more common after nasal endotracheal anæsthesia

than after anæsthesia carried out by other methods. I unhesitatingly said that this was not so as far as my own cases were concerned.

For the last five years a large proportion of the anæsthetics given for my work in three different hospitals, and also for my private cases, have been given by the nasal endotracheal method; I can remember no case, in many hundreds, where a pulmonary complication arose. I was given Dr. Massey Dawkins' article to read, and I must say that I was surprised that lung complications should have been met with so frequently. I am always extremely careful to avoid operating until some time has elapsed after any acute infection of the upper respiratory tract. This I have learnt by experience is the best way, at any rate for a throat surgeon, to avoid lung complications.

Another anæsthetist, Mr. J. W. HUMAN, *sends us the following*:

In the January number of the Journal you publish an account by Dr. C. J. M. Dawkins of two cases where nasotracheal intubation is an apparent cause of post-operative death from pneumonia.

It would be interesting to know whether Dr. Dawkins sprayed cocaine solution into the nares in these two patients before intubation?

At one of the hospitals to which I am attached I never cocainise before intubation, and at this hospital, during the last year, the house surgeon has reported to me that two patients whom I had intubated developed "chests" afterwards.

Elsewhere when I intubate I always cocainise first with a 20 per cent solution of cocaine, and so far have not had any "chest" with suspicion on the tube.

It would be instructive to know the experiences of other anæsthetists on this point as it is just possible that 20 per cent cocaine might sterilise the nares and pharynx sufficiently to prevent infection being carried down by the tube.

Finally, Dr. R. J. MINNITT *writes*:

After reading with much interest the article by Dr.

C. J. M. Dawkins on "Pulmonary Complications following Nasal and Endotracheal Anæsthesia", a few impressions gained from my own experiences may be worth recording.

In the first place, it does not seem to me that so long as a sterile tube is inserted through the nose into the trachea with ease and dexterity that any harm results to the patient. There are certain points, however, that I would stress as being of importance in accordance with my own practice.

(1) I much prefer a small tube to a large one, although I think this is more difficult to insert by blind intubation.

(2) The tube should be well lubricated with, say, sterile vaseline.

(3) If cocainisation is not performed then the anæsthesia should be deep enough for the insertion of the tube between the vocal cords without spasm. I think that this is one of the most important factors in the prevention of damage to the larynx.

I am much more inclined to think that the cause of pulmonary complications which have been found to follow anæsthesia conducted by means of an intratracheal tube lies in the quiet respiration of the patient, and the consequent hypo-ventilation of the lungs, rather than in septic material being carried down from the nasal cavity into the trachea by the catheter. If the anæsthetic is so given that re-breathing takes place into a Magill's bag, the carbon-dioxide produced will prevent this hypo-ventilation. Quiet respirations should not be allowed for too long periods at a time, these periods being confined to the stages of the operation when the surgeon requires very little abdominal movement.

I quite agree with Dr. Dawkins that the welfare of the patient is the most important point in selecting an anæsthetic, but it must always be remembered that the risk of pulmonary complications may be the lesser evil which one has to meet when dealing with an exasperated surgeon who is fighting with the abdominal muscles, and trying to keep

back the abdominal contents. To prevent this the only alternative would be a very deep ether anæsthesia, which would probably run the patient into a greater risk. I certainly feel that care should be exercised in selecting the endotracheal route, which can indeed be of much assistance in difficult cases.

AN INVESTIGATION INTO THE RISKS OF FIRE OR EXPLOSION IN OPERATING THEATRES

BY

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THE risk of explosion in operating theatres is obviously confined to those occasions when an anæsthetic is used which will give off a combustible vapour. The following have been considered and, where it seemed necessary, experiments have been made.

(1) Ether
(2) Chloroform
(3) Alcohol, chloroform, and ether
(4) Ethyl chloride
(5) Ether and oxygen
(6) Ether and nitrous oxide.

Chloroform alone of these is non-inflammable, and will impart some measure of non-inflammability to any liquid with which it is mixed. The combination of alcohol, chloroform, and ether seemed likely to yield an explosive mixture and, similarly, ethyl chloride appeared to be likely to be dangerous. Ether was obviously, either when used with air and oxygen, or probably with nitrous oxide, likely to yield an explosive mixture.

Preliminary experiments showed that the ordinary A.C.E. mixture yielded an explosive vapour with air, as did ethyl chloride. Both were easily combustible.

The following points have been investigated:

(1) The limits of explosion of mixtures of ethyl chloride vapour and air.

(2) The limits of explosion of mixtures of ether vapour and air.

(3) The limits of explosion of mixtures of ether vapour and oxygen.

(4) The limits of explosion of ether vapour and nitrous oxide.

(5) The explosibility of mixture of ether vapour, oxygen, and carbon-dioxide from Boyle's and Shipway's ether saturators.

(6) The distribution of ether vapour in an operating theatre during an operation.

(7) Experiments on the distribution of ether vapour from the liquid evaporating in air.

(8) A technique for the collection, storage and examination of mixtures of air and ether vapour.

(1) *The limits of explosion of mixtures of ethyl chloride vapour and air.*

A series of experiments was made in a cylindrical tinned iron canister 28.7 cm. high and 17.5 cm. diameter holding 7 litres and weighing, with lid and stirrer of tin and copper, 701 grms., giving a thermal capacity of 70–80 calories. The stirrer was introduced through a hole in the lid near the periphery, and two electrodes of brass wire No. 14 S.W.G. insulated from one another and giving a spark gap of about 2 mm., passed through a cork, fitted centrally in the lid, to half-way down the cylinder. A good Rhumkoff coil was used to produce a spark between the electrodes and a glass window was placed over an aperture in the lid.

It was at first intended to introduce the ethyl chloride in sealed tubes which would be broken, by the stirrer, within the vessel, but it was found difficult effectively to seal these tubes, and in most of the experiments the liquid was brought into a graduated cylinder (10 ml. in 1-10 ml.),

and the volume noted when boiling had ceased. The liquid was immediately tipped into the canister, the window closed and the stirrer worked for a short time to ensure complete mixing of the vapour formed by volatilisation of the liquid with the air in the vessel. A spark was then passed.

The following table shows the results of 17 experiments:

Percentage of ethyl chloride vapour		
2.5	No explosion	
3.9	do.	
3.9	do.	
4.3	do.	(flame gave slow burning)
4.8	do.	(,, ,, ,, ..)
4.8	do.	
4.8	Exploded	
5.3	do.	
5.3	do.	(blew lid off)
6.3	do.	
6.5	do.	
8.4	do.	
10.1	do.	
12.6	do.	
15.1	do.	(mild explosion and slow burning)
16.2	No explosion	(spark to open window caused flash and burning)
16.9	do.	(burned after interval with window open)

The range of explosibility is from rather below 5 per cent to rather over 15 per cent of vapour, and mixtures slightly outside these limits may burn if a flame is brought near.

The hydrochloric acid produced as a result of the combustion, which takes the course

$$C_2H_5Cl + 3O_2 \rightarrow 2CO_2 + 2H_2O + HCl$$

is extremely irritant.

A 50 ml. bottle of ethyl chloride would yield enough vapour to render about 11½ cubic feet of air explosive.

(2) *The limits of explosion of ether vapour and air.*

This question has been fully investigated by E. Berl and

H. Fischer (Z. Elektroch, 30, 1924, 29), who summarise their own and others' work, in a table:

Author	Diameter of glass explosion vessel	Explosion limits Lower	Upper
	c.m.		
Berl and Fischer	18	2.44	5.61
Eitner	19	2.70	7.90
White and Price	25	2.38	6.15
do.	50	2.05	8.00
	Iron vessel		
Berl and Fischer	18	2.34	6.15
White and Price	50	2.29	7.95
do.	100	1.80	—

From these results which, in the main, agree with our own, it would appear that mixtures of ether and air are likely to be explosive under varying conditions within the limits 2 per cent to 8 per cent of ether vapour.

(3) *Ether vapour and oxygen.*

Experiments were made in the Council's laboratory with weighed quantities of ether in sealed tubes, broken in a Bunsen absorption tube over mercury and in presence of oxygen, carefully evaporated and a measured proportion transferred to a vessel of about 320 c.c. capacity diluted with a known volume of oxygen and brought to atmospheric pressure

0.38%, 0.82%, 0.98%, 1%, 1.65%, and 1.72%,

gave no explosion but some burning, shown by the deposition of water vapour on the walls of the vessel, occurred. Two and two-tenths per cent gave a strong explosion. Oxygen saturated with ether vapour at 18° did not explode. The lower limit of explosion is probably rather below two per cent of ether vapour.

(4) *The limits of explosion of mixtures and ether and nitrous oxide (gas)*

Nitrous oxide is endothermic, and it has been found that

when detonated with fulminate it decomposed with violence.

The following experiments were made with nitrous oxide and ether vapour:

5.4 ml. ether vapour + 320 ml. N_2O (with some air which leaked in) = a mixture containing 1.69% ether gave, when sparked, a violent explosion.

18.68 ml. ether vapour in about 250 volumes = 7.5% ether vapour gave a violent explosion, shattering the flask.

Further experiments were made in a Bunsen eudiometer at reduced pressures. Combining all results it was found that:

1.35%	ether	vapour	gave	no explosion
1.69%	,,	,,	,,	a strong explosion
1.75%	,,	,,	,,	a violent explosion
2.76%	,,	,,	,,	a violent explosion
6.55%	,,	,,	,,	a violent explosion
7.5%	,,	,,	,,	shattering explosion
*7.95%	,,	,,	,,	explosion with red-hot platinum wire
15.3%	,,	,,	,,	no explosion

15.3% (at higher pressure and more of mixture) gave good but not strong explosion.

16% at atmosphere pressure gave explosion, but not strong.

17.53%	,,	,,	,,	no explosion
21.8%	,,	,,	,,	no explosion
28.8%	,,	,,	,,	no explosion

59% (saturated with ether) no explosion.

The limits at atmospheric pressure are probably from 1.5 per cent to 16 per cent of ether vapour in the mixture. The experiment illustrates the danger of diathermy.

(5) *The explosibility of mixtures of ether vapour and oxygen from "ether saturation" used in anæsthesis.*

Samples of gas were taken from two forms of Boyle's

* Bunsen eudiometer used as explosion vessel.

apparatus, one bubbling, the other with the gas impinging on a saturated wick in a vessel of ether, by Drs. Stebbing and Wimbush at Lambeth Hospital on 16th July, 1931.

We collected, in small stoppered bottles, containing sufficient mercury to form a seal when inverted, three samples as under from the wick form of Boyle's apparatus and two from Shipway's apparatus, which is also used at the hospital.

Boyle:
1. Ether, gas (N_2O) and oxygen (? with 5% CO_2)
2. Gas and oxygen, no ether
3. Ether, gas, and oxygen (higher pressure of oxygen)

Shipway:
4. Ether and oxygen
5. Ether, chloroform, and oxygen

The following observations as to explosive properties of these gases were made:

1. 16 c.c. of gas at 210 mm. pressure and 19.3°C a strong explosion.

*2. No explosion (one not expected) and no appearance of burning of nitrogen or continued sparking.

*3. Sparked at atmospheric pressure. Violent shattering explosion destroying the explosion pipette.

*4. No explosion, but addition of about three volumes of air gave a mild explosion.

5. About 10 ml. exploded when sparked at a pressure of about one-quarter atmosphere, notwithstanding the presence of chloroform.

The explosion vessels used both had electrodes near the upper part, and the cooling effect would be greater than in a vessel with central spark gap.

The coil used gave a good spark.

* Bunsen eudiometer used as explosion vessel.

(6) *The distribution of ether vapour in an operating theatre during an operation.*

Two series of tests were made in the large operating theatre of Lambeth Hospital.

On February 11, 1935, Dr. J. Nairn Dobbie and the Chemist collected the following samples, using the technique described later, which was designed to prevent any possible alteration of the samples of gas during the interval between collection and examination. Sampling was performed as rapidly as possible, starting when the patient had been under anæsthesia for half an hour:

Time when operation started—2 p.m.
Nature of anæsthetic—ether.
Type of ventilation of theatre—extraction fan.
Height of head—3′ 9″.
Temperature—76°F.

Distance from mask	Height	Time	Bottle No.	Examination					Ether vapour p.c. v/v.
				Explosion				Inflammability −, +, ++	
				Violent	Strong	Weak	None		
7″	3′ 9″	2.30	1				—	−	0.00
7″	floor level		2				—	−	0.00
28″	44″		3				—	−	0.00
28″	floor level		4				—	−	0.057
8′	4′ 6″		5*				—	−	0.006
8′	floor level		6†				—	−	0.013

* 5 Just over radiator-switch.
† 6 Ground level in front of radiator ("ground level" = 4″ above floor).

It will be noted that none of the samples was either combustible or explosive, and that although higher proportions of ether were found at the ground level, the percentage in no case approached two per cent, which is approximately the lower limit of explosibility. The first three samples gave results which could not be distinguished from those obtained in blank determinations by the method of analysis used, and were therefore considered to contain less than 0.01 per cent ether vapour by volume.

These results were unexpected, but it was felt that they were accounted for by the density of ether vapour. It was felt desirable to take a further series of samples in the region of a patient's head.

This was done on March 21, 1935, by Dr. Dobbie and the Chemist. The same technique was adopted. The patient had been under anæsthesia for one hour, and ten ounces of ether had been used up to the time of sampling. Ether was then still being dropped at intervals on the mask.

Time when operation started—2 p.m. (10 ozs. of ether had been used).
Nature of anæsthetic—open ether.
Type of ventilation of theatre—extraction fan.
Height of head—3′ 9″.
Temperature—83°F.

Distance from mask	Height	Time	Bottle No.	Examination					Ether vapour p.c. v/v.
				Explosion				Inflammability −, +, ++	
				Violent	Strong	Weak	None		
3″ from mouth	Level of patient's mouth	3 p.m.	1				+	−	0.27
2″ from mouth	do.		2				+	−	1.89

Barometer 760 mm.

It is noteworthy that even two inches from the patient's mouth, or rather from the mask over it, a non-explosive mixture was obtained, whilst the falling off of ether content of the air with distance is marked, and sufficient to explain the earlier results.

In view of these results it was decided to investigate the diffusion of ether vapour when allowed to evaporate freely from a liquid surface.

(7) *The diffusion of ether vapour into air above a surface of liquid ether.*

The composition of the mixture of air and ether vapour at different heights above a freely evaporating surface of liquid ether should yield information of direct value in estimating the probable danger of fire or explosion when a bottle of ether is accidentally allowed to fall to the floor and break. It should also throw some light on the general

question of the diffusion of ether vapour into the air from free ether surfaces.

It was sought first to investigate the case of ether evaporating over the whole of the floor of a cylindrical vessel in still air. The ideal case would be a tall cylinder of infinite length, but as any actual apparatus approximating to this would present great constructional manipulative difficulties, a cylinder of height (38.5 cm.=)15¼ in. approximately equal to its diameter (38 cm.=)15 in. constructed of enamelled iron was used, protected by a concentric cylinder of corrugated millboard (66 cm.=)25¾ in. high and (60 cm.=)23½ in. diameter. By this means it was sought to reduce air currents to a negligible amount. The contents of such a cylinder are 43.6 litres=1.5 cubic feet and the floor area 1,134 cm.^{2}=177 in.^{2}. Cups containing mercury were suspended about 4 cm. from the walls at angles of approximately 120° around the inside of the vessel at heights which would allow collection of the mixture of air and vapour 3 cm., 20 cm., and 32 cm. above the floor. A disc of blotting paper covered the floor to afford a uniform surface for evaporation of the ether as the floor was not perfectly plane. Sampling could be effected by merely lifting mercury filled gas tubes standing in the cups.

An amount of ether rather less than would yield enough vapour to fill the cylindrical vessel at the partial pressure corresponding to the room temperature was left in a stoppered bottle, with the rest of the apparatus overnight and was next morning emptied on to the blotting paper. In 22 minutes a slight smell of ether could be detected around and above the outer vessel and after 27 minutes a smell of ether was observed six feet away, becoming strong after 42 minutes. Between 43 and 45 minutes from spilling the ether while the blotting paper was still wet, the three graduated sampling tubes were raised and allowed to become partly filled with the air-ether vapour mixture in the vessel, beginning with the bottom one. The air in the vessel at the top was then found when inspired to give rise to the feeling of a beginning of anæsthesia.

The three gas samples were then tested for explosibility and combustibility and the ether content determined by

micro-combustion after dilution with air with the following results:

Sample	Height from base	Sparking test	Burning test	%Et_2O v/v From CO_2	%Et_2O v/v From H_2O
Bottom	3 cm.	No explosion	Burning at flame	40.00	40.73
Middle	20 cm.	No explosion	Burning at flame	19.02	19.09
Top	32 cm.	Vigorous explosion	Burning at flame	3.34	3.35

When the percentages of ether were plotted against the heights from the evaporating layer, they were found to be on a straight line. If this linear relationship may be accepted, the concentration at the evaporating surface would have been 44.5 per cent, diminishing to nothing at 34.5 cm. above. The former figure probably represents fairly closely the saturation point, since although the room temperature was 19°C. the evaporation of ether would have lowered this considerably at the evaporating surface. On Ramsay and Young's data, 40 per cent would correspond to saturation at 11.5°C. at a total pressure of 760 mm. The concentration in a tall cylinder would doubtless have fallen off more slowly above the height of 32 cm. than the linear relationship obtained in the vessel used would seem to suggest as the vapour in a tall vessel would not be able to fall over the sides as it certainly did in the experiment.

This experiment is, however, of considerable practical value as indicating the order of concentration of ether vapour which would be obtained up to about a foot (31 cm.) above an evaporating surface when the vapour was restrained from falling or diffusing laterally until it reached that height, or the condition close around the centre of a pool of ether on the floor of a draughtless room. In either case it is reasonable to suppose that the lower limit of explosion, which is about 2 per cent of ether in the air, would be passed less than two feet above the evaporating surface and the air above this would be safe. The former case could never exist on or by an operating table as it would require the patient to be walled in all round his head,

whilst in the second, if such concentrations as those found tended to occur above the centre of a pool of ether, the heavy mixture would spread laterally and the gradient of dangerous concentration would be confined to a very small height above the pool.

An experiment was made on March 21, 1935, in the small operating theatre at Lambeth Hospital, after a series of operations with ether-chloroform.

A four-ounce bottle of ether was emptied on the floor of the theatre and three samples of air were taken at approximately the centre of the pool thus formed at the same heights as in the cylinder experiment and at the time when the pool had spread to a maximum. Although the temperature was only 64°F. evaporation was very rapid and the liquid ether had disappeared soon after sampling. The following concentrations of ether vapour were found:—

Sample	Height from base	Sparking test	Burning test	From CO_2	From H_2O
Bottom	1.18 ins.	Exploded	Did not burn	2.12	2.64
Middle	7.87 ins.	Did not explode	,,	0.19	0.30
Top	12.6 ins.	,,	,,	0.11	0.30

It will be noted that only the bottom sample was explosive, the concentration of ether falling away rapidly with height (the calculations from carbon-dioxide are probably the more trustworthy). The form of the curve shows that the rate of dispersion under such conditions is much more rapid when the vapour can spread laterally as well as diffuse vertically.

It would appear from these two series of tests that danger of explosion at more than a few inches above the floor is negligible, except in so far as rapid convection might be induced.

Two other series of experiments on the vertical diffusion of ether may be cited.

Ether in a flask provided with a long vertical delivery tube bent at right angles towards its upper end was kept boiling by a flameless source of heat, so that a strong

stream of vapour issued in a direction initially horizontal. A small gas flame was supported above the vapour stream. When the flame was two inches above the horizontal part of the tube immediately over the issuing ether vapour this occasionally ignited. At four inches ignition occurred less often and at four and a half inches did not occur even when the vapour was blown upwards. Observation in sunlight showed that the main vapour stream fell rapidly from the point of issue.

Ether was poured into a metal tray approximately 6 in. × 4 in. and ¼ in. deep and a small gas flame was supported 1½ inches above the centre of the tray. The ether was not lighted for some minutes. On a second occasion the flame was 3¼ inches above the evaporating surface. In ten minutes the whole of the ether had evaporated without flame or explosion. During this time the temperature fell from about 65°F. to 35°F. owing to the cooling effect of the evaporation.

In a third experiment 20 ml. of ether (=0.7 oz.) was allowed to evaporate from the tray. The temperature fell in eight minutes to 27.9°F. and then slowly rose, but the ether all evaporated without being ignited by a flame 3¼ inches above.

In a fourth experiment 10 ml. of ether was used and the air was fanned sufficiently to disturb the ether surface. The temperature fell to 26.6°F. in three minutes and the remaining liquid was mainly water condensed from the air. The ether was not fired by a flame 3¼ inches above its surface.

All these experiments show that the vapour of ether, which is more than 2½ times as dense as air of the same temperature, tends to fall or spread horizontally as the liquid evaporates, a tendency which is increased by the lowering of temperature consequent on evaporation.

(8) *Method used for determination of ether*

In order to estimate the ether content in ether-air mixtures, it was decided to employ the Pregl micro method of ultimate combustion as being the most satisfactory for mixtures of such widely varying composition.

Before actual determination, some idea of the strength of

the mixture was obtained in each case by sparking a small sample in a weighted eudiometer standing over mercury on a rubber pad, and by open flame test where necessary.

For the estimation the standard Pregl combustion apparatus was used, and was established as working satisfactorily by the determination of carbon and hydrogen in known substances. The modification made to deal with ether-air mixtures was as follows:—

Between the U-tube of the bubbler and the combustion tube proper a short length of capillary tubing was inserted from which a side capillary tube (sealed in) led upwards for about 15 cm. and then down nearly to bench level and finally up for about 25 cm. In order to decrease fluctuations in the rate of flow of gas through it a constriction was made in the capillary by drawing out close to the T-joint. The open end was expanded somewhat, drawn out finely, and sealed off. (The expansion gives a drawn out part which has thinner walls and is thus easily broken.) The long and narrow U-tube thus formed stood in a cylinder of mercury which initially was filled above the capillary end. A graduated and calibrated tube, into which the sample was introduced over mercury, and measured at noted temperature and pressure, was lowered over the sealed end of the capillary as far as possible. Mercury was then removed from the cylinder by means of a pump until the mercury levels inside and outside the graduated tube were the same. A tap-funnel containing mercury was arranged above the cylinder. When all was ready for combustion, the graduated tube was sharply depressed to break the sealed end of the capillary, and was then fixed in this lower position. Mercury was then allowed to flow in from the funnel at such a rate as to cause the introduction of the sample at a suitable speed into the main oxygen stream.

This method of introduction of the gas to be examined into the stream passing into the combustion apparatus was used to avoid any contact with lubricant which might absorb ether.

A check on the method made by the determination of carbon and hydrogen in a specially prepared two per cent ether-air mixture yielded satisfactory results.

In cases where the spark test showed it to be desirable the sample was first diluted with air.

Summary.

1. The limits of explosion of mixtures of ethyl chloride vapour and air have been investigated and found to lie between 5 per cent to rather over 15 per cent by volume of ethyl chloride vapour in the mixture.

2. The conclusions of previous workers that mixtures of ether vapour and air are explosive within the limits of 2 per cent and 8 per cent of ether vapour have been confirmed as regards the lower limit.

3. The lower limit of explosion of mixtures of ether vapour and oxygen has been investigated and found to be rather below 2 per cent of ether vapour. The upper limit is probably higher than in the case of air.

4. The limits of explosion of mixtures of nitrous oxide and ether vapour have been found to be between 1.5 per cent and 16 per cent of ether vapour.

5. Experiments with two forms of Boyle's apparatus showed that the mixtures—ether, gas and oxygen, ether and oxygen or ether, chloroform and oxygen, delivered from this apparatus are either explosive or combustible.

6. The distribution of ether vapour in an operating theatre during operations under open mask anæsthesia has been examined on two occasions. Even after prolonged use of ether in this way, the concentration of ether vapour in the room is very small, the air at about two inches of the patient's mouth containing less than would form an explosive mixture, and the proportions falling off very rapidly, as the distance from the patient increased.

7. The diffusion of ether vapour into air above a surface of liquid ether has been investigated under two sets of conditions. When the vapour is prevented from spreading laterally the concentration of ether in the air varies from approximate saturation (about 40 per cent) about an inch above the ether surface, a mixture which would burn but contains too little air to be explosive, to an explosive mixture (3.35 per cent) about a foot above the surface, the decrease being proportional to the height. This condition

represents what might be expected in a room in which a large volume of ether sufficient to saturate the air of a room was spilt on the floor and uniform but restricted ventilation was provided by exhausts all round the walls at a height of a foot.

The actual ether content of the air when ether is spilt or a bottle broken on the floor of a small room was found to be very much less owing to (1) the lateral spread of vapour around the pool which is formed, (2) the density of ether vapour (2.55 when air=1), and (3) the cooling effect on the liquid of the formation of vapour. At about one inch above the pool the air was rendered explosive, but at eight inches and twelve inches the concentration was very small.

8. A technique has been evolved for the collection and storage without alteration of samples of mixtures of air and ether vapour or of air and other vapours which may be affected by water or grease, and for the analysis of mixtures of air and ether vapour of all possible compositions.

Conclusions.

1. Ethyl chloride yields a vapour which forms an explosive mixture with air and its use is dangerous in proximity to flames or apparatus likely to yield a spark or hot wires.

2. Ether or mixtures of ether with chloroform or alcohol and chloroform vapour and oxygen or nitrous oxide obtained in and delivered from ether saturators of the usual type are likely to be explosive either *per se* or when they become diluted with air and present dangers under the conditions mentioned in (1).

3. The danger of explosion or burning with open mask ether anæsthesia is very small indeed owing to the rapid descent of ether vapour through air.

4. Explosions due to dangerous concentrations of ether vapour in the air of an operating theatre, even after the accidental breaking of a bottle of ether, are most unlikely if the possible source of ignition is a foot or more above the floor level and not directly under the liquid ether spread on the mask or other surface.

A RARE SEQUEL TO INTRAMUSCULAR INJECTION

Brief notes appeared in the general press of a fatality following intramuscular injection of evipan, and believing that the details of so unusual an occurrence would be of interest to our readers we applied for these to Dr. D. P. Harris, of the Derbyshire Hospital for Women, where the death occurred. Dr. Harris has been kind enough to furnish us with the account which follows. The intramuscular use of evipan is, we believe, not very widespread. Anæsthetists who formerly employed the method inform us that they have abandoned it on account of the frequency of local trouble at the site of injection. This has not as a rule been serious, but has been an inconvenience arising sufficiently often to make the practice undesirable in the opinion of those who practised it. Certainly when, during the intravenous use of evipan some of the fluid is inadvertently injected *outside* the vein, there is often a little local trouble in consequence. This would lead us to avoid the purposeful injection of the fluid anywhere except directly into a blood-vessel.

Here is Dr. D. P. HARRIS'S account:

"This case may prove to be of some interest, for it graphically portrays one of the most appalling tragedies that may follow so simple an operation as the giving of evipan intramuscularly, or for the matter of that, the giving of any hypodermic or intramuscular injection.

"In this case the patient, aged 40, was admitted to hospital in the best of health clinically for a diagnostic curettage following a hydatidiform mole. Evipan chosen as an anæsthetic was given first of all in the usual dose of 10 c.c. intravenously, but as this did not produce sufficient surgical relaxation a further 5 c.c. was given into the muscles of the right thigh, after following the usual practice of sterilising the skin with methylated spirit thoroughly. The syringe and needles, of course, were sterilised in the usual manner

by boiling and storing in spirit. This additional dose of the anæsthetic produced excellent relaxation and the operation was completed without incident. This took place on the morning of February 16th, 1937.

"February 17th, morning. The patient complained of some pain in the right thigh, but nothing abnormal was noted on examination. Towards evening, as the pain was more acute, the leg was raised on pillows, which seemed to give it some relief.

"February 18th, morning. On examination the leg was found to be very much swollen, especially in the middle third, just over the site of injection; there was definite evidence of gas gangrene infection as shown by the presence of crepitations and gas under the skin just above the knee. As soon as the diagnosis had been made serum was employed, but by evening the infection had spread to the level of the inguinal ligament and was just beginning to attack the abdominal wall. By 11.30 p.m. the patient was dead.

"The cause of death was obvious, but it was confirmed by a post-mortem examination by Dr. Osborne, who said in his opinion, the case was almost without precedent. At the autopsy when the leg was laid open a large gaseous and sloughy area was brought into view, with typical smell which left the diagnosis without doubt. It was obvious that infection had been introduced through the skin-puncture with the needle, the extra fluid forming the injection must have caused a local necrosis of the muscle bundles and this of course produced the ideal environment, devitalised muscle fibres and a complete lack of oxygen, for the incubation of the *Bacillus welchii.*

"No blame can be attached to the evipan, for any fluid capable of causing disruption of the muscle fibres would have produced the same result. This bacillus, in its spore form, is extremely resistant to normal sterilizing measures, even withstanding one and a half hours' boiling, so it can easily be seen how difficult it is to eliminate this organism except by causing grave damage to the skin. This only indicates briefly what may happen at any time following an injection, be it anæsthetic or not."

ANALGESIA FOR LABOUR PAINS

Dr. R. J. Minnit sends us the following note:

At the meeting of the Section of Obstetrics and Gynæcology held on February 19th, 1937, I was present at the demonstration given by Mr. Chassar Moir of a new type of apparatus for the self-administration of nitrous oxide gas during labour. The chief point about this apparatus was the inhalation of two deep breaths of pure nitrous oxide gas at the onset of each pain. I had an opportunity after the meeting of testing the length of time the gas took effect, and am of the opinion that the analgesia produced would not be long enough adequately to relieve the pains of labour.

Dr. Hilda Garry, who assisted me in the research work, carried out on the original gas-air apparatus, which allows of the delivery of a mixture of gas and air during the whole of the time of the painful contraction, has made the following communication, which may be of interest:

THE DURATION OF LABOUR PAINS

By Dr. Hilda Barry,
Hon. Anæsthetist, The Liverpool Stanley Hospital.

It is now generally admitted that analgesia is a very important factor in midwifery, and inhalation analgesia has given very successful results.

In using this method it is important to know something of the duration of labour pains, so that one can be certain that the apparatus used supplies sufficient analgesic power to make the patient insensitive to the pain.

During the investigation of the Minnitt gas-air apparatus at the Liverpool Maternity Hospital in 1933–34, I was fortunate enough to have the opportunity of supervising a number of cases in labour. Under Dr. Minnitt's direction

I timed the pains in a group of cases, and the result of this investigation is tabulated as follows:

Pains lasting (1) under 30 seconds.
(2) between 30 and 60 seconds.
(3) between 60 120 seconds.

	1st Stage	2nd Stage
Under 30 seconds	1	1
Between 30 and 60 seconds	11	13
Between 60 and 120 seconds	10	8

From this table it will be seen that the largest proportion of cases had pains lasting from 30 to 60 seconds, but quite a number had pains lasting well over 60 seconds, and many as long as 120 seconds. The latter must be taken into account when inhalation analgesia is given, for it is of little use the patient being oblivious to the pain for 60 seconds, and then becoming conscious of it when it is either at its height, or beginning to decrease.

Conclusions

1. Any analgesic must continue for at least 60 seconds.

2. It must be able to be prolonged by the patient's inhalations for a sufficient length of time to cover the duration of any pain.

ABSTRACTS

"Epidural anæsthesia in general surgery." C. B. ODOM, in *New Orleans Med. and Surg. Journ.*, January 1937. p. 349.

THE author maintains that it is possible through a simple puncture and without entering the subarachnoid space to produce analgesia sufficient for any operation below the chin. He has used the method for two hundred and fifty operations. Odom attributes the little use made of the method to the blind mode of localising the epidural space described by Dogliotti. His own method depends on utilising the negative pressure in the space, a glass indicator connected to the spinal needle showing plainly by the loss of its liquid the moment when the space is entered. The anæsthetic solution is then injected with ease, 10 c.c. being first used. Then up to 50 c.c. are injected in lots of 15 to 20 at a time. If after five minutes there is no numbness of the lower limbs it is certain that the subarachnoid space has not been entered. After injection the patient lies flat on the table. If the operation is on the pelvis or lower limbs he is placed in Fowler's position; if on the upper abdomen or chest, a slight Trendelenburg position is adopted. The author believes that with correct technique epidural is the safest form of anæsthesia available, and that it is receiving less attention than it merits.

"Experiences with the short anæsthesia of Eunarcon." DR. F. J. SCHMITT, in *Schmerz, Narkose u. Anæs.*, December 1936, p. 153.

EUNARCON is the latest barbiturate anæsthetic, and is allied to pernocton, inasmuch as, like that drug, it contains bromine. Both its action and its detoxication by the liver are said to be very rapid, in fact all the virtues of evipan are claimed for it. The author has used it some 600 times for chest operations only and does not recommend it for anything else; when a longer time is require he continues

with ether. He gives no other drug before the eunarcon, which he injects slowly into the vein, the first 3 c.c. taking at least two minutes. He requires 3 c.c. as the minimum dose and 10 c.c. as the maximum. Generally he found that 7 to 9 c.c. was the dose required. The symptoms relied on for determining the dose are as with evipan. Patients suffering from heart disease and from bronchitis stood eunarcon well. There was almost invariable freedom from sickness and from headache on awakening, but there were a few instances of restlessness.

"Post-operative lung complications." P. DUVAL and Z. BINET, in *Presse Medicale*, November 14 1936, p. 1800.

THE extent to which the anæsthetic must be held responsible for troubles within the chest after operation has long been a matter of dispute. Those who believed that the anæsthetic had little to do with causing the trouble were apparently upheld in their opinion by the commonly acknowledged fact that after operations conducted with spinal analgesia chest troubles were apparently as frequent as after inhalational anæsthesia. Duval and Binet have carried out experiments in order to explain the genesis of post-operative lung troubles not caused by inhalation anæsthetics, venous emboli, or dissemination from a septic focus. Their object was to confirm the idea that the complications might be caused by an intoxication, following any surgical intervention, from autogenous albumins (polypeptides which do not cause shock) produced by operative trauma and disseminated by the blood-stream. Polypeptides from the muscles of dogs were injected into two series of other dogs, one series normal, the other sensitised by subcutaneous injection of polypeptides. The normal series showed no lesions. On the other hand in the sensitised animals lesions were found in the lungs. These were of two kinds: (1) atelectasis with dilated vessels, and (2) alevoli distended with blood. These changes correspond to those found in man. The authors then cite a human instance which supports their theory. A man died four days after an exploratory laparotomy done under local anæsthesia. Post-

mortem the histological changes found in the lungs were similar to those in the experiments. Moreover, two days before his death the blood contained 80 mg. polypeptides per 100 c.cm., nearly three times the normal figure.

"Nupercaine in Rhinolaryngology." P. A. TICKTON in *Canadian Med. Assoc. Journ.*, February 1937, p. 177.

THE author prefers local to general anæsthesia whenever possible in operating on nose or throat. Nupercaine in 2 per cent solution for surface analgesia, and 1 in 1000 solution for injection is the anæsthetic which he finds most successful, and the only one that gives a sufficiently prolonged analgesia. When injected he uses it with 10 drops of adrenaline 1 in 1000 to the ounce. For surface application the nupercaine solution is mixed with a 3 per cent. solution of ephedrine hydrochloride. Two hundred and fifteen tonsillectomies by dissection were happily carried out under this system of local analgesia.

"Evipan for delirium tremens." P. SERBER, in *New England Journ. Med.*, 1936, 215, 1065.

THE use of anæsthetics for therapeutic purposes other than narcosis seems to become increasingly common. We have recently recorded instances of the value of avertin, for example, in the treatment of tetanus. Now evipan comes into the picture as a valuable aid in the control of a delirious patient. Obviously the intravenous administration may be a matter of difficulty when the patient is both delirious and violent. In one instance given by the author it needed six helpers to keep the patient still enough for safe injection. When this was achieved, however, the effect was rapid and admirable. The solution used was the usual 10 per cent in distilled water, and an initial dose of 2 c.c. was first injected slowly. When the patient fell asleep another 1 c.c. was put in. The author relates three cases, and in each the patient slept after the evipan injection from eighteen to twenty-four hours. This is, of course, a small number on the basis of which to recommend a treatment, but their excellent results make it certain that a new field for evipan injection is worth further cultivation.

CORRESPONDENCE

Unusual Reaction to Avertin.

Dear Sir,—Your recent request for descriptions of cases illustrating the strange mental phenomena associated with anæsthesia leads me to send this account of the reactions of a patient following a rectal injection of avertin.

The patient was a woman in the thirties who was to have a small cyst removed from her breast. The operation might well have been performed under local anæsthesia, but the patient insisted that she must be put to sleep in bed beforehand. I discussed with her the relative merits of avertin and evipan, and she chose to have the former, (*a*) because it acted half an hour beforehand, and (*b*) because she disliked skin-pricks. I ordered a dose of avertin at the rate of 0.1 gram per kilo of body-weight, and saw it given the next morning, forty minutes before the advertised time of operation. I arranged for an injection of atropine to be given in another fifteen minutes, by which time I thought the patient would surely be asleep. After five of these fifteen minutes she announced that she was beginning to feel queer and that 'it was beginning to work'. Instead of falling asleep, however, she began to talk brightly and vigorously; she mentioned that she rode to hounds, and that she was very abstemious, never drinking anything other than gin-and-tonic; she wondered why she was so wide-awake; surely it was time she was asleep. This continued, and I held up the atropine until a quarter of an hour before the arranged time of the operation. Then, seeing the syringe and feeling the prick of the needle, she complained that she had expected to go to sleep with the avertin alone; surely it could hardly be necessary to give her a hypodermic injection too. The talking went on clearly, emphatically, and without pause. At five minutes to zero the porters arrived with a trolley, but there was still no sign of narcosis. I

went up to the theatre and collected an open mask and a tube of ethyl chloride, and on my return found the nurses trying to move the patient to the trolley. The patient was protesting loudly; she felt wide-awake and not at all ready to go to the theatre; she was very comfortable in bed; the trolley looked hard and uncomfortable; she refused to be moved.

Feeling that the situation was hopeless, I induced anæsthesia with the ethyl chloride, but not before the patient had told me that I must be very inefficient, for neither my rectal nor my hypodermic injection had had any effect and I was reduced to smothering her in a very crude and old-fashioned and unpleasant manner. The ethyl chloride was sufficient to maintain anæsthesia until we reached the theatre, where the operation was completed under gas and oxygen.

From the point of view of a patient demanding basal narcosis we had had a complete failure, or so it seemed; and when I returned to visit the patient some hours later I expected to be met with a storm of abuse. To my amazement she was perfectly pleased! From the moment—about five minutes after the recal injection—when she had begun to feel drunk she had no recollection of the morning at all. To one who had listened to her rapid, eager talking, and had been submitted to her very marked criticism, this amnesia was astonishing, and, of course, very pleasing. I heard from the nursing staff that on her departure from the home two days later, the patient was still completely oblivious of the resistance she had shown to our attempts to narcotise her.—Yours etc.,

London, W.14. G. Edwards (M.R.C.S., D.A.)

REVIEW

"Recent advances in anæsthesia and analgesia." C. LANGTON HEWER, M.B., D.A. (T. & A. Churchill, London, 1937, p. 284; price 15/-).

IT is no surprise to find a second edition of Dr. Hewer's admirable book. During the five years that have passed since its first issue there has been much progress in anæsthetic administration. New drugs have been introduced, as well as new and modified methods. All these are well described in the present edition, which is larger than the first in spite of elimination wherever possible. Dr. Hewer's book is not for beginners; it takes for granted an acquaintance with the fundamental principles of anæsthetics and with traditional simple methods. It is, however, an excellent work for the specialist, because of its author's wide knowledge, sound opinions, and clear exposition. His work in connection with the surgery of the thyroid and with severe operations on the chest is well known, and there are no better portions of his book than those treating of these subjects. Cyclopropane and divinyl ether have both come into the field of practical anæsthetics since the first edition, and both are fully discussed in the present volume. An excellent chapter deals with modern machinery for administration of gaseous anæsthetics. An interesting comment on evipan is that it seems to be "extremely dangerous in quinsy". In the chapter on local analgesia reference is made to the diagnostic use of paravertebral block in distinguishing between pains due to the gall bladder and those depending on other viscera. Similarly, it is pointed out that spinal block is of service in determining the likelihood of sympathectomy being of use in the treatment of thromboangitis obliterans. We have mentioned only one or two items of interest; the book is full of others, and we recommend it warmly to our readers.

OBITUARY

An Appreciation of Henry Charles Roberts.

THE death of Henry Charles Roberts in his forty-fourth year on March 15th has robbed our little corner of Cheshire, and indeed Merseyside, of one whom to know was to love.

He qualified in 1916, and served in the Great War in Mesopotamia. After practising for a short time in Liverpool, he came over to Moreton, in Cheshire. He was a naturally gifted mechanic, and early became interested in anæsthetics. He designed and at first, with his own hands, made a portable gas-oxygen-ether apparatus, a modification of what he thought best in the American Foregger and Heidbrink machines. Latterly he had much improved this, and, when the Cunard-White Star liner *Queen Mary* was being equipped, his apparatus was installed in her.

To those of us, his colleagues, who were willing to learn, he freely and generously gave of his special knowledge, and made clearly plain what others seemed to have kept a mystery, and this with undoubted financial loss to himself.

As anæsthetist to the Liverpool Dental Hospital, I believe it is true to say that he revolutionised dental anæsthetics, and his lectures, with cinematograph films of dental anæsthesia, were becoming increasingly sought after.

He was skilled in all forms of his art, including evipan, avertin, ethylene and cyclopropane administration, and, at the time of his passing, was engaged on simplifying and making more ecnomical the use of the latter.

He was an accomplished musician and photographer, and a keen student of nature, delighting especially in his garden, and I shall always picture him coming to my poorly-gardened house, his arms filled with flowers.

His never-failing cheefulness, generosity and unassuming kindliness had meant so much, that his unexpected death has caused consternation to his professional colleagues, friends and patients, and, among these latter, the poor, who worshipped him.

He leaves a widow and one son, to both of whom he was deeply devoted.

W. G. McA.